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EFFECTIVE DEVELOPMENT OF THE ADVANCED DIRECTIONAL SHEAR
CELL AT WATERWAYS EXPERIMENTAL STATION(U) UNIVERSITY
COLL LONDON (ENGLAND) J R ARTHUR 23 OCT 87

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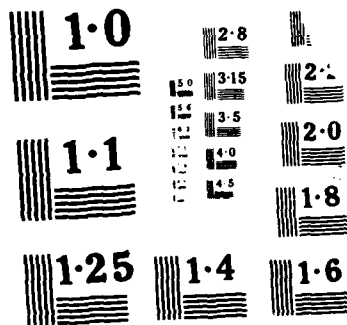
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FIRST PERIODIC REPORT

JUNE 18th-AUGUST 18th

1987

SECOND PERIODIC

AUG 18th - OCT 19th 1987

EFFECTIVE DEVELOPMENT OF THE ADVANCED DIRECTIONAL SHEAR CELL

AT WATERWAYS EXPERIMENTAL STATION

CONTRACTOR: A.S.U. University college, London, U.K.

PRINCIPAL INVESTIGATOR: J.R.F.Arthur

The Research reported in this document has been made possible through the support and sponsorship of the U.S. Government through its European Research Office of the U.S. Army. ~~This report is intended only for the internal management use of the Contractor and the U.S. Government.~~

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All the specified electronic control equipment has been delivered and set up together with the advanced DSC itself. This has been done By John Pulsford the University College Research Assistant employed through this contract. He is working on the equipment full time carrying out tests agreed with WES personnel. Initial apparatus capability tests have been completed using pluviated samples of dense and loose Leighton Buzzard sand. It has now been decided to embark on an experimental research programme concurrently with initiating Dan Leavell of the WES Geotechnical Research Facility into the maintenance of the device, the preparation of samples and the testing of the same. There has been a 15 day visit by the principal investigator which substitutes for the two 5 day visits allowed for in the contract. This enabled an interim solution to the problem of strain measurement to be worked out and a thorough discussion of the testing program. Progress to date appears excellent.

The only disappointment to date concerns the failure to obtain adequate strain measurements from the sample boundaries. It was recognised that there would be difficulties in this at the design study stage so provision was made in the design for alternative techniques using radiography or photography. Radiography provides the best quality but it is expensive and requires special radiation protection in the form of thick dense walls or lead sheet. Photography using a plate camera has been adopted for the present. A preliminary assessment of the accuracy was $\pm 0.4\%$; more repetitions in determining the coordinates of selected markers should improve this; 10 as against 3 are being tried now. It has also been agreed to keep WES informed of an investigation at UCL into the use of bend elements to determine the dynamic shear modulus. This should go along way to solving the problem of small strain and small strain increment measurement.

The initial research program aims to explain why when testing a dense Leighton Buzzard sand a jump rotation of 70° in the principal stress directions after reaching a stress ratio of 6 leads to a softer response than a jump of 90° in the same circumstances. A proposition put forward by the principal investigator that it is due to the particle structure created by very short displacement Coulomb slips is being tested. This proposition is based on an interpretation of a different research program concerned with distributed boundary restraint and disturbance which is being carried out at UCL. Further research is planned into a cyclic expansion and contraction in dense sand during large single sense rotation of the principal stress directions (360°). This was first observed during a proving test on this DSC at UCL and it seems likely to be an important clue to fundamental material behaviour but the possibility of an apparatus effect has to be excluded by more experiments.

Although the performance of the DSC is pleasing there has been a problem for WES personnel in finding time to assimilate the rather complex techniques involved. It seems likely that an extension of the contract is needed to give an appropriate amount of time for this vital stage.

J.R. Arthur

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The work is in an intermediate stage in which no firm research findings can be reported, but this is entirely as one would expect. Very good progress is being made in terms of data gained, improving apparatus performance and especially in familiarising Dan Leavell and other WES personnel with the operation of the equipment. Thus the main objective of this contract is being achieved.

Many small modifications have been made to the equipment to study the effects on performance and adopt when improved performance is noted. Replacement parts have been fitted to the shear sheet guidance system to increase the range of strain that can be imposed above the original specifications. These parts may have an outside chance of improving boundary strain measurements as an additional bonus and trials will be made. Improvement in the uniformity of normal stress transfer has been achieved by fitting specially shaped silicon rubber pads between the front face of the normal pressure bags and the back of the shear sheets. The use of these pads appears to eliminate a discrepancy in data obtained in this DSC and earlier designs; similar effects were observed during the development of these earlier designs.

Development of photographic strain measurement techniques continues and video recording is being tried. It has already proved valuable in allowing the generation of rupture layers to be studied. In parallel with this a brittle coating on the sample membrane has been introduced to allow rupture layer orientation to be recorded. There is further work to be done on strain measurement techniques.

Tests to date have shown a consistent change in rupture layer orientation to Coulomb; cyclic DSC tests currently being carried out at UCL show a similar change in a subsequent monotonic phase and should help to explain these results. It is too early to report in a helpful way on data obtained to date. There are some surprises in the results that need careful evaluation. The new DSC is operating in a pleasingly reliable way and this has perhaps encouraged the concentration on testing rather than analysis. Nevertheless this concentration will best fulfill the major purposes of the contract which is to familiarise WES personnel with the equipment. The analysis will catch up in due course.

JKE Arthur

23.10.87

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